DOCUMENT RESUME

ED 078 044 TM 002 859

AUTHOR Stiggins, Richard J.; Byers, Joe L.
TITLE Stability of Semantic Factor Structure and Change in Connotative Meaning of Educational Concepts During Teacher Training.
PUB DATE Feb 73
NOTE 23p.; Paper presented at annual meeting of American Educational Research Association (New Orleans, Louisiana, February 25-March 1, 1973); Ph.D. Dissertation, Michigan State

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS Concept Formation; *Concept Teaching; *Factor Analysis; *Semantic Differential; Semantics; *Teacher Education; Technical Reports

ABSTRACT

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STABILITY OF SEMANTIC FACTOR STRUCTURE AND CHANGE IN CONNOTATIVE MEANING OF EDUCATIONAL CONCEPTS DURING TEACHER TRAINING[1]

Richard J. Stiggins and Joe L. Byers
Michigan State University

A Paper Presented at the American Educational Research Association Annual Meeting, New Orleans, February 1973.

[1] This study is based on a doctoral dissertation completed at Michigan State University by the senior author (Stiggins, 1972) and was sponsored by the Education 200 Research Council (Research Report #7), College of Education, Michigan State University, East Lansing, Michigan.

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A series of eleven concepts, eight of which were systematically presented in a teacher training course, were rated by 252 undergraduate education majors on fifteen semantic differential scales at the beginning and at the end of the course in an attempt to assess changes in the factor structure (dimensionality) of semantic space and changes in the connotative meanings of the concepts. Scales (bipolar adjectives) selected to represent the traditional EPA structure developed by Osgood, were found to be best explained by a four factor solution which deviated from the hypothesized structure. This structure was found to be stable over time and factor scores for each orthogonal factor demonstrated significant gains in directions consistent with the goals of teacher training.

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A prime concern of those dealing with the evaluation of educational programs is the creation of new methods of quantifying observation through the application of already existing psychometric techniques in new and untested ways. The reason for the primacy of this concern is, of course, that new uses of observational procedures increases the breadth and scope of the potential tools available for plotting the influence of an educational program. This study deals with an initial exploration of such a novel application in the hope that, at some point in the future, it will contribute valuable information for the planning of future instruction.

More specifically, an attempt has been made to assess the influences of instruction during teacher training on the affective reactions of trainees to the pedagogical concepts, tools and procedures presented in instruction by means of the semantic differential scaling procedure (Osgood, Suci and Tannenbaum, 1957). Kerlinger (1964) has raised questions concerning the stability of the factor structure of semantic space as measured by the semantic differential (Osgood, et. al., 1957) during teacher training experiences. Walberg, et. al. (1968) and Hoover and Schutz (1968) have attempted to deal with the question of change in the semantic meaning of concepts as the result of teacher training, but the question of changing dimensionality is as yet unanswered. The purposes of this study were to (1) assess the factor structure of the semantic meaning space of educational concepts to determine if the traditional "evaluative," "potency" and "activity" supply; (2) to determine if the factor structure of ratings remains stable when measured before and after a teacher training experience; and (3) to further assess the changes in

connotative meaning of concepts as a result of such an experience; in the hope that the results would lead to meaningful conclusions concerning changes in affective reaction to concepts, where affect is operationalized as semantic differential ratings. Given meaningful conclusions, a potentially useful application of the semantic differential technique would be revealed.

Instruments

A semantic differential (S.D.) instrument was developed using eight concepts systematically presented in a teacher training course in educational psychology. These concepts reflected the two phases of the course. One phase dealt with the task demands of teaching through presentation of psychological concepts related to teaching such as: Reinforcement, Shaping, Respondent Learning and Behavioral Objectives. The second phase treated the personal demands of teaching by dealing with such concepts as: Non-verbal Behavior, Questioning and Listening Skills, Myself As A Teacher, and Myself. In addition to these eight concepts, three were added which were unrelated to Teacher Education: Marijuana, Religion, and Physician. These were included in the absence of a control group as a quasi control for the purpose of drawing some tentative conclusions concerning the cause of changes.

Each of these concepts was rated on 15 bipolar adjective scales selected on the basis of prior research and pilot testing to represent the traditional evaluative, potency and activity dimensions of connotative meanings, as defined by Osgood, et. al. The scales used were as follows:

Evaluative	Potency	Activity
unfair - fair	worthless - valuable	relaxed - tense
bad - good	lenient - severe	passive - active
negative - positive	weak - powerful	insensitive - sensitive
unimportant - important	gentle - violent	still - moving
uninteresting - interesting		
unpleasant - pleasant		
unenjoyable - enjoyable		

The order and direction of these scales on the S.D. instrument was determined by means of a randomization procedure.

These S.D. elements were combined with instructions adapted from the Osgood, et. al. instructions to form the test booklet with one concept per page (OpScan response sheet).

Subjects

The subjects were 252 undergraduate education majors at Michigan State University who were enrolled in the first course in the teacher training sequence. This figure represents 81% of the enrollment during the term when ratings were gathered. Since part of the affective or connotative meaning reactions sought were intended to be of concepts familiar to the respondent, subjects were eliminated who had not demonstrated mastery of the denotative (definitional) meaning of each concept at the time of final rating.

Procedures

The data collection procedures stipulated that the 11 concepts be rated on the 15 scales during the first and the last week of instruction. The time interval between collections was approximately nine weeks during which students were proceeding through the instructional sequence. The S.D. booklets administered at each time were identical except for slight adjustments in the instructions to make them appropriate for the time of the rating.

Analyses

The purposes of the analyses were to (1) test the hypothesis that a three factor solution (evaluative, potency and activity factors) was the most parsimonious explanation of the scale interrelationships; (2) test the hypothesis that this factor solution was stable over time; and (3) that there were changes in the connotative meanings of individual concepts within this factor structure or frame of reference.

The first hypothesis was tested by means of an unlimited maximum

likelihood factor analysis (Joureskog, 1965) which yields a chi-square test of goodness of fit of a factor model, Cattel's (1966) Scree test based on a graphic representation of latent roots, and by means of a rational analysis of the factor loading matrices. The correlation matrix of scale ratings was factor analyzed separately for each concept on both the pretest and the post-test. However, due to the similarities among these 22 factor solutions and due to the complexity of interpreting 22 solutions, the correlation matrix which resulted from pooling concept ratings over pretest and posttest were also factor analyzed. The two resulting factor solutions are reported and dicusssed below.

The second hypothesis, concerning factor structure invariance, was assessed by means of a Pearson product moment correlation coefficient, correlating factor loadings of scales on comparable factors from the pretest and the posttest factor loading matrices, as suggested by Cattell (1966).

The test of the final hypothesis of change in individual concept meaning was based on pretest and posttest factor scores generated by employing factor loadings as regression weights and computing a sum of weighted ratings in accordance with the procedures and formulation suggested by Harman (1960):

$$Y = X\, S^{-1}\, \hat{\Lambda}$$

where Y is the matrix of factor standard scores, X is the matrix of variable scores, S^{-1} is the inverse of the variance-covariance matrix, and $\hat{\Lambda}$ is the varimax rotated factor loading matrix. This computational procedure resulted in a factor score for each concept on each orthogonal factor for both pretest and posttest ratings. In order to test the hypothesis of alteration in concept meaning, changes in factor scores (post minus pre) for each concept served as multiple dependent measures in a one factor one level multivariate analysis of variance designed to assess the difference of each change from zero. This test was carried out separately for each orthogonal factor.

Results

Factor Structure

It was clear by all criteria (X^2 test, Scree test, and factor loading patterns) that a three factor solution was inappropriate. Space limitations do not permit presentation of all results. A complete analysis may be found in Stiggins (1972). However, Table 1 does report the results of the X^2 test of goodness of fit of the three factor model. Since the hypothesized structure was appropriate in only two of the 22 factor analyses,

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Insert Table 1 about here
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it was concluded that a more complex latent structure was operating and further analyses were carried out to discover its dimensions.

Extensive manipulation of the pooled and unpooled scale correlation matrices and a careful consideration of all of the criteria listed above revealed that the most parsimonious factor solution, from both a statistical and a rational point of view, was a four factor model. Once again, space limitations do not allow for a complete representation of the data.[1] However, the pretest and posttest varimax solutions reported in Table 2 provide evidence of the latent factors or dimensions of connotative meaning which were tapped

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Insert Table 2 about here
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by the scales selected. These factor loadings suggest that the scales were interrelated in such a way as to represent the following dimensions:

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[1] See Stiggins (1972) for complete description of the factor solutions.

Meaning Dimension	Characteristic Scales	Meaning Definition
Evaluative	worthless - valuable bad - good negative - positive unimportant - important	This dimension represents the respondent's favorable or unfavorable reaction to the concept in terms of how it affects others.
Personal Evaluative	unenjoyable - enjoyable unpleasant - pleasant (uninteresting - interesting)	This dimension reflects the respondent's favorable or unfavorable reaction in terms of his own personal values or from the point of view of how it affects him.
Leniency	severe - lenient tense - relaxed violent - gentle (insensitive - sensitive) (unfair - fair)	These scales reflect the meaning of the concept from a flexibility point of view or on an open vs. closed dimension.
Potency	active - passive still - moving weak - powerful	This factor represents a reflection of the manifest or observable power and activity potential of each concept rated.

Factor Structure Invariance

As reported in Table 3, there was a very high degree of stability in the factor structure as demonstrated by the high correlations between loadings on

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Insert Table 3 about here
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comparable pretest and posttest factors. It is inferred from this that respondents employed the scales to relate the same dimensions of meaning at the beginning and at the end of instruction. It was then possible to assess changes in the meanings of concepts within these stable factors or dimensions of meaning.

Changes In The Connotative Meaning Of Concepts

The factor loading matrices reported in Table 2 were combined with the raw responses in the manner prescribed by Harman (1960) to yield an index of

an individual's favorable or unfavorable reaction to each concept (evaluative dimension) at the beginning and at the end of the term, how he reacted to it on the personal evaluative (pleasant - unpleasant) dimension, his reaction in terms of its leniency, and the potency he perceived in each concept. The change in each of these reactions over the terms of instruction, defined as the difference between the factor scores (post minus pre), was then assessed on each dimension.

Tables 4 - 7 report the MANOVA's of change on each of the four dimensions. It is apparent on the basis of the multivariate F's that there were significant

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Insert Table 4 about here
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overall changes on the Evaluative (multivariate $F = 28.43$, $p < .0001$), Leniency (multivariate $F = 4.98$, $p < .0001$), and Potency (multivariate $F = 8.24$, $p < .0001$) dimensions, but not on the Personal Evaluative (multivariate $F = 1.74$, $p < .0651$) dimension. Further, it is apparent that changes occurred in the instructional concepts which did not occur in the noninstructional concept group. Evidence of this is seen in the Step Down F's in Tables 4-7. Reading from the bottom of that column, the three noninstructional concept mean changes must be considered significant, however, the univariate F's temper this slightly. On the Evaluative dimension (Table 4) Questioning and Listening Skills and Reinforcement show minimal change. Small changes in the Potency dimension (Table 5) are seen for Myself and, on the Leniency (Table 6), Non-verbal Behavior, Myself, Behavioral Objectives and Reinforcement changed a little.

However, these change data supply only part of the picture provided by the data. The factor score means also provided information for a geometrical interpretation of the connotative meaning ascribed to each concept (Osgood, et. al., 1957). For example, by using the orthogonal factor scores as vectors

in Euclidean space, one is able to construct an N dimensional semantic meaning space, where N is the number of orthogonal factors. In this particular case, four orthogonal factors were extracted. However, there were significant changes on only three of these. Consequently, a three dimensional space was constructed to reflect the connotative meaning of a concept with respect to the Evaluative dimension (favorable - unfavorable), the Potency dimension (potent - impotent) and the Leniency dimension (severe - lenient). The mean factor score (over subjects) for each dimension, both pre and post, as reported in Table 8, was then plotted on the three orthogonal axes. The location of each concept in this semantic meaning space is reported in Figures 1 - 3. Each of the three concept categories is reported separately to add clarity

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Insert Figures 1 - 3 & Table 5 about here

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to their relative positions. In each case the arrow indicates the change from pre to post. Since no concept was rated severe, the figures include only the lenient half of the lenient - severe/favorable - unfavorable principle plane.

Discussion

Scale Interrelationships and Factor Analysis

The finding that the Osgood EPA structure was inappropriate when scales had been selected to reflect those dimensions reinforces two points made in prior thinking concerning S.D. research. The result (i.e., unexpected four factor solution) reinforces the validity of the Smith (1961) and Heise (1969) argument that the dimensionality of semantic space must be reassessed for each new application of the technique. In addition, it supports the Wittrock (1964) finding the EPA structure, though appropriate for the general meaning domain, does not seem to apply to concepts from Teacher Education. And finally, this result reveals potential errors which can be made in S.D. research by

choosing scales on the basis of prior research and to generating factor scores without verifying that the desired latent structure has in fact been tapped.

Some discussion of the four factor latent structure seems warranted. The Evaluative dimension is a manifestation of the dimension of meaning tapped most frequently and which regularly accounts for the largest amount of common variance in S.D. research. It is interesting to note, however, that a second factor of an evaluative nature has been tapped. This is the Personal Evaluative factor. Though there is a conceptual similarity between favorable and unfavorable reactions in terms of how a concept affects others and a favorable to unfavorable reaction using one's self as the frame of reference, there are indications that these are independent judgments. That is, it would seem that the judgment as to the value of a pedagogical tool is made somewhat independently of personal like/dislike considerations. The remaining two factors, leniency and potency, appear to be a breakdown and reassembly of Osgood's potency and activity dimensions. For example, the scale weak - powerful is most closely associated with elements of the Osgood activity dimension (active - passive), and violent - gentle which characterizes Osgood's potency dimension is associated with tense - relaxed which has been considered an element of the activity scale in the Osgood research. These variations in factor structure deserve further exploration and verification in future research.

The question of the stability of the latent structure requires little discussion, except that the high degree of invariance sheds some light on the question posed earlier by Kerlinger. It would seem that, in this particular case, this component of teacher training experience has little influence on the dimensionality of the educational semantic space of the trainee.

Individual Concept Meaning Change

It was stipulated that if instructional concepts changed in meaning and the noninstructional did not change, some tentative inferences as to the

cause of the change would be possible. Since this was in fact found to be the case, the tentative suggestion that the instruction did contribute to the change seems warranted. However, more convincing evidence could have been obtained with a slight alteration in the concepts employed. If a category of general educational concepts (not presented in instruction) had been rated, there would have been information available on which to decide if instruction had influenced only instructionally relevant concepts or had merely brought about gross changes in attitude toward education which would be reflected in any educational concept. On the basis of the data presented here, such a gross alteration in emotive responses cannot be ruled out as a plausible rival explanation for the results. Further research must clarify this point if the S.D. procedure is to supply useful information in the evaluation of specific courses and course content.

The relative magnitudes of the changes which took place in the different concepts suggest an interesting relationship between the initial state of connotative meaning and the potential for changing that meaning. The concepts which showed greatest change were Behavioral Objectives, Respondent Learning and Shaping. The prior meaningful associations or experience which respondents had with these terms are probably minimal in relation to the prior experience they had had with such concepts as Myself, Non-verbal Behavior or Questioning and Listening Skills. This suggests that there is an inverse relationship between familiarity with a concept and the amount of change in connotative meaning which can be achieved in a person's reactions to the concept when the amount of energy (i.e., instruction) expended in bringing about such a change is held constant. This relationship deserves further exploration, because it may serve as an important link between denotative meaning (cognitive) and connotative meaning (affective).

The locations of the concepts in the three dimensional space are also of interest. First, the widely different meanings of the noninstructional concept and the location of marijuana in the unfavorable domain add credibility to the psychometric technique, because these might be expected from a rational point of view. The two clusters of instructional concepts (self vs. procedural) also lend some support to the validity of the measures, because one might expect these to exist in the domain of connotative meaning (i.e., the self more lenient than tools employed in the classroom). This research would probably be classified as dealing more with the tools, concepts and procedures than with the self. But, perhaps this instrumentation or technique could be profitably applied to self consideration in more detail, as in measuring changes in individual perceptions of self and others.

The question of the actual connotative meaning of the concepts (location in semantic space) and the changes therein lead directly to the discussion of the appropriateness of these meanings for teacher training. It would seem that, since each of the instructional concepts were seen as favorable, potent and lenient, students are predisposed to use them in constructing a learning environment. Further, since they were seen as more favorable, potent and lenient after instruction, the influence of instruction was to increase the predisposition. However, it should be made clear that this may be reading too much into the data. There is no proof that scores on S.D. rating of educational concept are predictive of later classroom behavior. Though there is no evidence that S.D. scores are predictive of behavior in other areas such as empathetic responses in counselors (Greenberg, 1970) and movement toward mental health (Endler, 1961), the assumption that the same relationship exists when classroom behavior is the criterion, may be invalid. The research reported here is proceeding on such an assumption for purposes of

developing the assessment technique and procedures, but the research cannot proceed much further until this validation study is carried out.

Conclusions

On the basis of a pretest - posttest administration of a semantic differential instrument on which undergraduate education majors rated eight concept tools and procedures relevant to instruction in teacher training, the following conclusions seem warranted:

1. For this particular set of educational concepts, the traditional evaluative, potency and activity dimensions are inappropriate, but there is a fairly clear four latent structure which seems to characterize the scale interrelationships.

2. This four factor solution is highly stable over the nine week period of teacher training which served as the treatment in this study.

3. There were discernible changes in the connotative meanings of the tool concepts and procedures rated on three of the four meaning dimensions tapped, which result in the concepts being rated as more favorable, lenient and potent at the conclusion of instruction than at the outset of instruction.

The issues that remain unsettled are the reproducibility of the factor structure, the inference of a cause and effect relationship between instruction and change in connotative meaning, and, most importantly, the relationship between these S.D. ratings and the actual classroom behavior of the teacher. Any statement as to the future of the procedures employed here as a valuable evaluation technique in teacher training must await resolution of these issues. However, the research reported here would appear to be a step in a fruitful direction.

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Table 1: Fit of the three factor model to the pretest and posttest correlation matricies

Concept	Pretest	Posttest
MYSELF AS A TEACHER	χ^2 = 93.5	χ^2 = 81.8[b]
NONVERBAL BEHAVIOR	154.4	136.9
QUESTIONING AND LISTENING SKILLS	99.4	106.5
MYSELF	152.9	166.7
BEHAVIORAL OBJECTIVES	134.2	170.2
REINFORCEMENT	135.7	152.1
RESPONDENT LEARNING	219.2	144.5
SHAPING	236.3	139.6
PHYSICIAN	132.1	78.1[b]
RELIGION	157.7	261.5

[a]The null hypothesis that the model does not fit the data is rejected at $\chi^2 \leq 82.22$ where $\alpha = .05$ and df = 63.

[b]Three-factor model fits.

Table 2: Complete factor matrices for four-factor solution of pooled variance-covariance matrices, pre and post.

Factor I.D.:	Pretest					Posttest				
Variable	Evaluative	Personal Evaluative	Potency	Leniency	h^2	Evaluative	Personal Evaluative	Potency	Leniency	h^2
Worthless-valuable	.789	-.170	.205	.268	.765	.815	-.161	.186	.231	.778
Severe-lenient	.020	-.067	-.040	.531	.289	.085	-.070	-.018	.548	.313
Unfair-fair	.416	-.178	.219	.576	.585	.506	-.199	.266	.479	.596
Good-bad	-.760	.209	-.166	-.294	.736	-.752	.236	-.169	-.310	.745
Tense-relaxed	.206	-.220	.117	.391	.357	.413	-.186	.152	.514	.342
Weak-powerful	.487	-.077	.370	.005	.380	.470	-.099	.409	-.005	.398
Negative-positive	.626	-.235	.257	.436	.703	.609	-.267	.281	.392	.675
Violent-gentle	.182	-.161	.152	.682	.548	.205	-.228	.227	.686	.652
Unimportant-important	-.733	.163	-.282	-.174	.673	-.767	.153	-.289	-.152	.718
Active-passive	-.418	.116	-.614	-.087	.573	-.370	.152	-.655	-.107	.601
Insensitive-sensitive	.300	-.152	.356	.553	.546	.347	-.241	.373	.469	.538
Uninteresting-interesting	.445	-.323	.400	.307	.556	.419	-.399	.346	.264	.523
Pleasant-unpleasant	-.320	.532	-.250	-.530	.729	-.301	.609	-.251	-.505	.779
Moving-still	.184	-.172	.657	.159	.520	.185	-.177	.714	.238	.632
Enjoyable-unenjoyable	-.291	.797	-.253	-.374	.926	-.308	.703	-.245	-.416	.823
Prop. Var.	57.7	10.9	4.5	5.4		54.9	9.8	6.0	5.0	
Cum. Var.	57.7	68.6	72.9	78.3		54.9	64.7	70.7	75.7	

Table 3: Pearson Product Moment Correlation Coefficients between Factor Loadings on each of the Four Meaning Dimensions

Meaning Dimension	Correlation Coefficient
Evaluative	.998*
Personal Evaluative	.993*
Leniency	.887*
Potency	.891*

* $p < .01$

	Individual Concept Changes				
	$\bar{X}$	Univariate		Step Down	
EVALUATIVE DIMENSION	Change	F	ps	F	ps
Myself as a Teacher	.1748	14.6749	.0002	14.6749	.0002
Nonverbal Behavior	.3288	30.3106	.0001	26.2311	.0001
Questioning and Listening Skills	-.0594	1.2661	.2616	1.8232	.1782
Myself	.2376	28.7822	.0001	16.2958	.0001
Behavioral Objectives	.5745	57.2381	.0001	46.8987	.0001
Reinforcement	.1273	4.8684	.0283	1.2254	.2694
Respondent Learning	.6662	89.0564	.0000	27.6389	.0001
Shaping	1.0439	205.0043	.0000	87.6834	.0000
Physician	.2826	14.4736	.0002	0.5649	.4531
Religion	.1295	4.3497	.0381	0.9137	.3401
Marijuana	.1762	7.3671	.0072	1.3500	.2465
LENIENCY DIMENSION					
Myself as a Teacher	.1032	5.6118	.0136	5.6118	.0186
Nonverbal Behavior	.0567	0.7388	.3909	0.0209	.8852
Questioning and Listening Skills	.1768	7.9529	.0052	7.6727	.0061
Myself	.0682	1.7833	.1830	0.2320	.6305
Behavioral Objectives	.0186	0.0659	.7976	0.3154	.5750
Reinforcement	-.0247	0.1224	.7268	0.5453	.4610
Respondent Learning	.2550	17.3521	.0001	11.1204	.0010
Shaping	.4318	37.3589	.0001	25.6025	.0001
Physician	.0292	0.2161	.6425	0.5677	.4519
Religion	-.0341	0.2038	.6521	0.3195	.5725
Marijuana	.0166	0.0530	.8182	0.0608	.8055
POTENCY DIMENSION					
Myself as a Teacher	.2739	30.4171	.0001	30.4171	.0001
Nonverbal Behavior	.2594	10.6794	.0013	4.7458	.0304
Questioning and Listening Skills	.2426	12.1528	.0006	3.2651	.0720
Myself	.1766	8.7039	.0035	1.6756	.1968
Behavioral Objectives	.4383	34.3504	.0001	14.7340	.0002
Reinforcement	.3536	26.3572	.0001	9.1825	.0028
Respondent Learning	.4112	36.1644	.0001	6.8243	.0096
Shaping	.4318	38.0995	.0001	7.4633	.0068
Physician	.2606	15.4934	.0002	1.6291	.2031
Religion	.1841	5.7773	.0170	0.5850	.4451
Marijuana	.0440	0.3373	.5620	1.1745	.2796
PERSONAL EVALUATIVE DIMENSION					
Myself as a Teacher	.1215	4.6531	.0320	4.6531	.0320
Nonverbal Behavior	.0409	0.2629	.6086	0.2241	.6361
Questioning and Listening Skills	.1191	1.8549	.1745	1.7434	.1880
Myself	.1544	6.2616	.0130	4.6452	.0322
Behavioral Objectives	-.0739	0.8365	.3613	1.4277	.2333
Reinforcement	.0019	0.0006	.9809	0.1368	.7118
Respondent Learning	.0197	0.0646	.7996	0.0362	.8498
Shaping	.1528	4.0215	.0460	3.6331	.0579
Physician	-.1269	2.3823	.1240	2.5557	.1112
Religion	-.1275	0.1454	.7034	0.0019	.9649
Marijuana	.0265	0.0937	.7598	0.0041	.9472

Table 4: Results of Multivariate Analyses of Variance of Change in the Connotative Meaning of Concepts on each Meaning Dimension.

Table 5 -Factor score means for each of the four major meaning dimensions for each concept.

Concept	Pretest					Posttest				
	Evaluative	Evaluative Self	Leniency	Potency	Overall Intensity*	Evaluative	Evaluative Self	Leniency	Potency	Overall Intensity*
Myself as a Teacher	.976	1.588	1.828	1.542	3.352	1.152	1.710	1.931	1.160	3.541
Nonverbal Behavior	1.189	.978	.989	.994	2.755	1.518	1.019	1.046	1.253	2.987
Questioning and Listening Skills	1.937	1.188	.984	1.069	3.228	1.877	1.306	1.161	1.312	3.315
Myself	.948	1.361	1.872	1.312	3.238	1.186	1.516	1.940	1.489	3.417
Behavioral Objectives	1.105	.970	.907	.770	2.538	1.679	.869	.925	1.208	2.935
Reinforcement	1.738	1.098	1.005	.995	3.011	1.865	1.101	.981	1.350	3.185
Respondent Learning	.925	1.067	.727	.736	2.232	1.591	1.087	.982	1.148	2.911
Shaping	.544	.881	.689	.788	2.114	1.588	1.034	1.121	1.220	2.942
Physician	1.332	.699	1.189	1.038	2.485	1.614	.573	1.217	1.299	3.037
Religion	.629	1.206	.915	.919	2.834	.758	1.179	.881	1.103	2.797
Marijuana	-.819	1.098	.689	.644	2.789	-.642	1.125	.705	.688	2.754

* Computed by the formula $\sqrt{E^2 + ES^2 + L^2 + P^2}$ to reflect the distance of each concept from the origin in four dimensional Euclidean space. For a complete discussion of this, see Stiggins (1972).

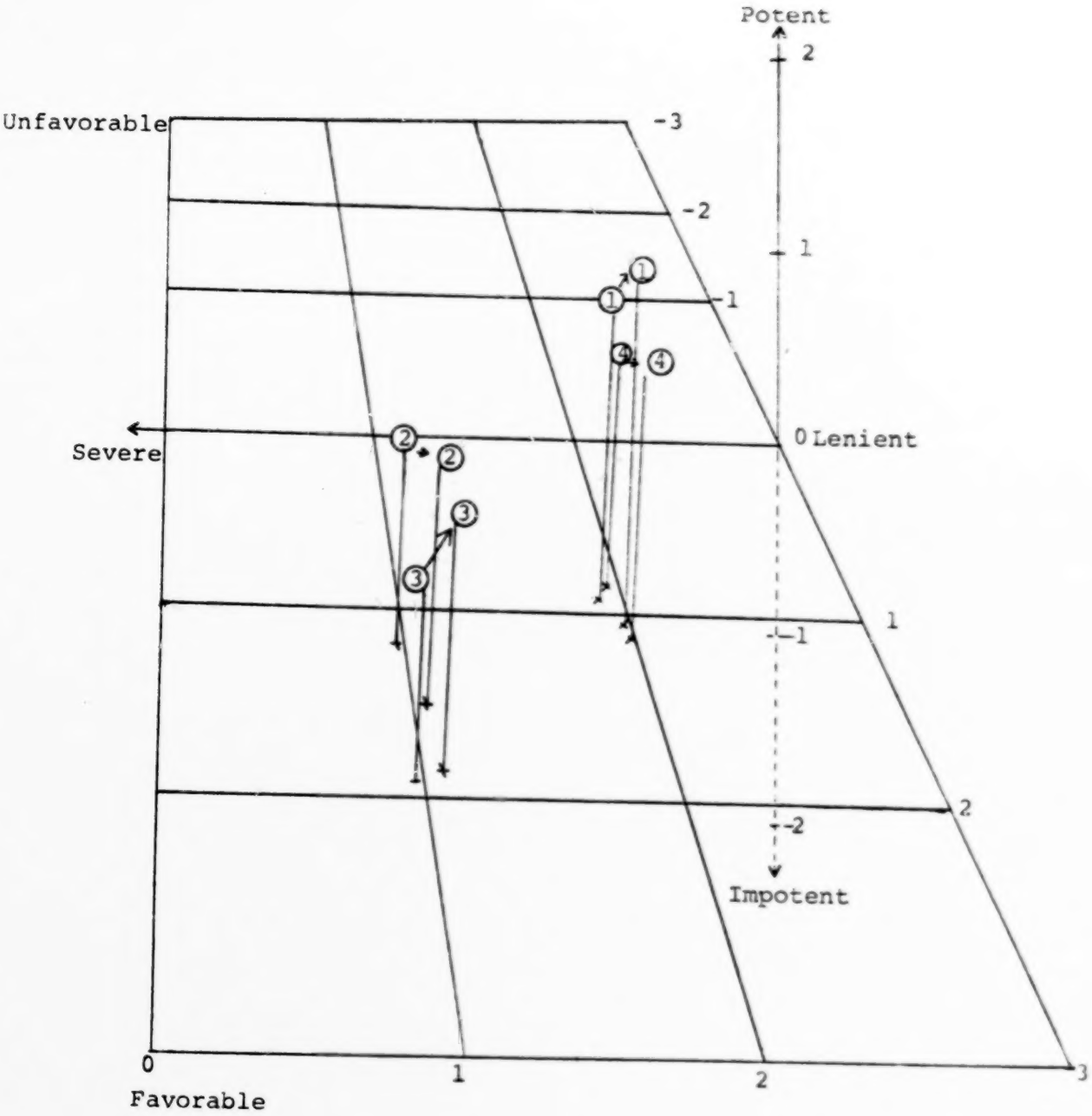

Figure 1. -Graphic representation of pretest and posttest meaning assigned to IPL concepts:

1. myself as a teacher
2. nonverbal behavior
3. questioning and listening skills
4. myself

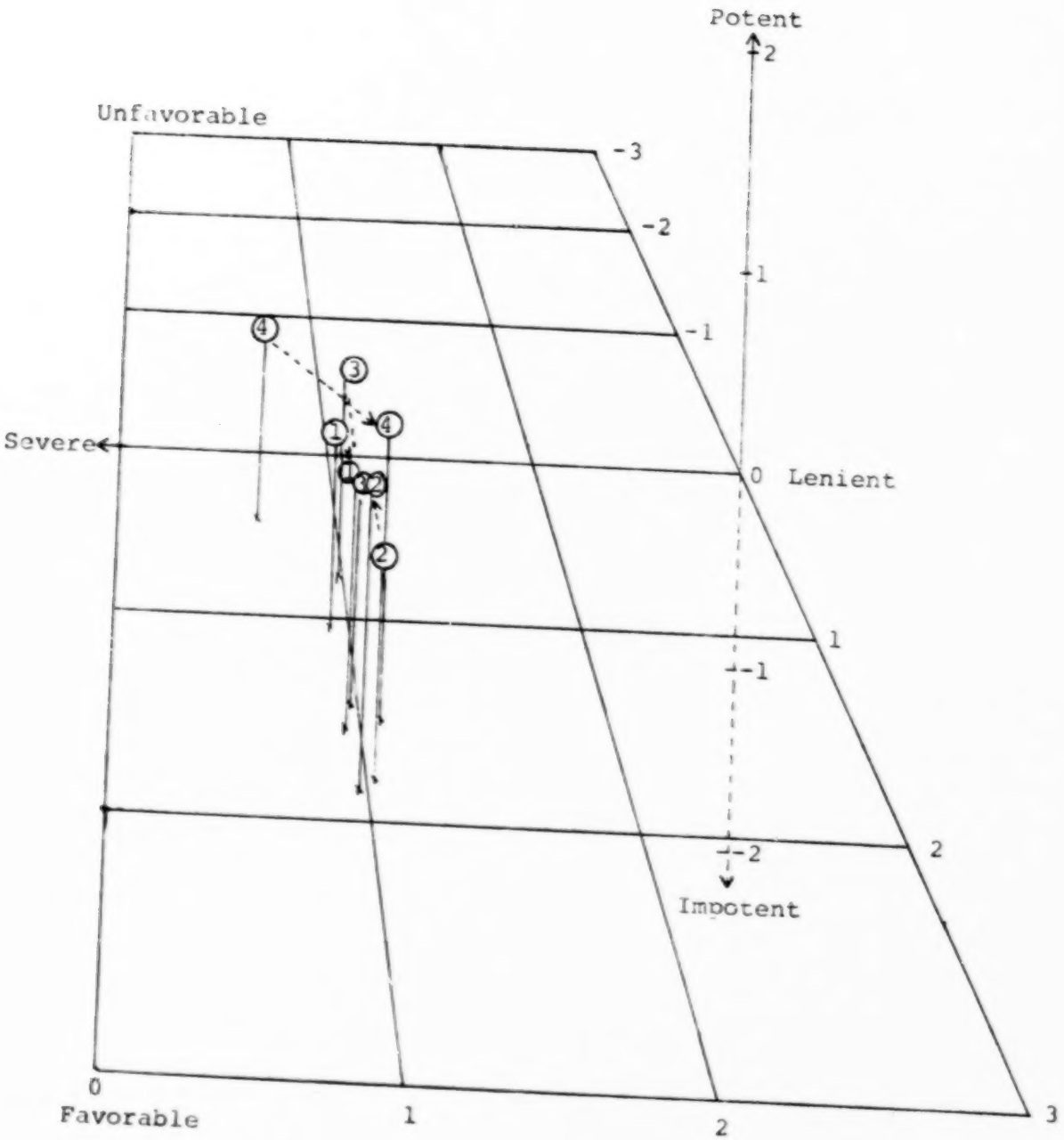

Figure 2. -Graphic representation of meaning assigned to Carrel concepts:

1. behavioral objectives
2. reinforcement
3. respondant learning
4. shaping

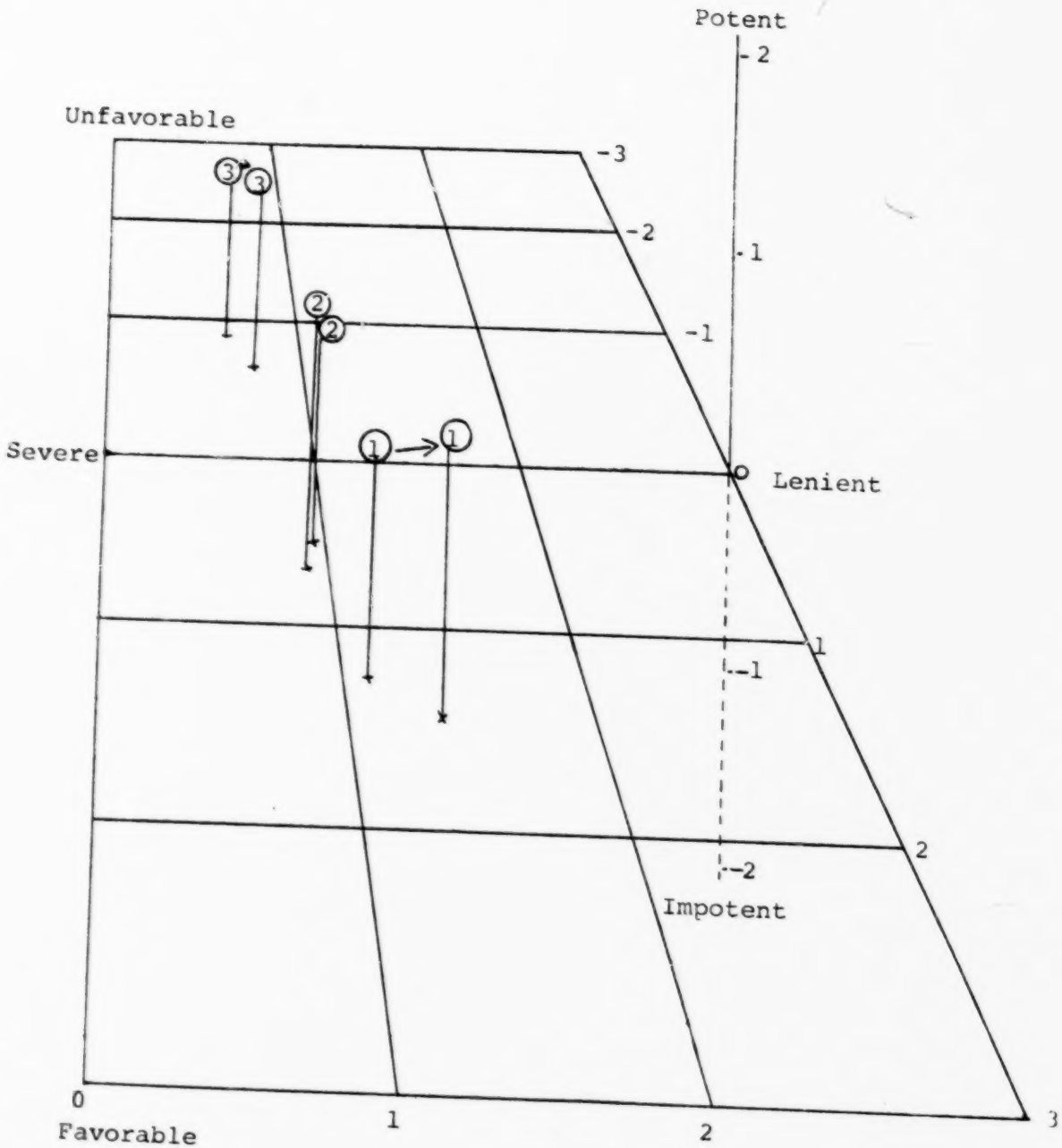

Figure 3. -Graphic representation of pretest and posttest meaning assigned to noninstructional concepts:

1. physician
2. religion
3. marijuana